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(54) **Method and device for preparing espresso coffee**

Verfahren und Vorrichtung für die Zubereitung von Espressokaffee

Procédé et dispositif pour la préparation de café

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Description

[0001] This invention relates to the preparation of espresso coffee, or Italian coffee, by percolating boiling water through a certain lightly pressed quantity of ground roasted coffee in powder form.

[0002] It is equally suitable for preparing espresso coffee starting from a single-measure or multi-measure coffee sachet formed of heat-resistant material able to act as a filter.

[0003] The invention is also suitable for preparing drinks from coffee substitutes, such as barley or the like.

[0004] Hereinafter, reference will be made exclusively to coffee, this term also embracing its substitutes.

[0005] Espresso coffee preparation machines for domestic or bar use comprise a hot water generator feeding a percolation chamber containing the coffee powder.

[0006] Said chamber commonly comprises the lower filtering wall, for example of perforated stainless steel, and is connected below a top piece through which the boiling water is fed.

[0007] Below the filtering wall there is defined a collection chamber for the percolated product which flows to the outside through a spout below which the cup is placed.

[0008] The quality of the product obtained depends both on the quality of the powder and on the ability of the operator, who has to press the powder to the correct extent to achieve uniform distribution of the percolating water through the entire coffee mass.

[0009] A commonly observed indicator in the user's judgement of the quality of the espresso coffee is the presence of froth, ie a creamy phase above the surface of the liquid phase.

[0010] The need to optimize the percolation stage, on which for equal powder quality the quality of the finished product depends, is obvious.

[0011] In the known art, in spite of full operator attention, there is a limit to the degree of utilization of the powder, as almost inevitably passages of lesser density form in the powder mass, creating preferential passageways for the hot water, which hence does not sufficiently traverse certain parts of the powder.

[0012] Said drawback is also present in automatic machines, in which the manner in which the powder is fed to the percolation chamber often does not ensure uniform water passage through the whole of the coffee powder.

[0013] The object of this invention is to propose and provide an espresso coffee preparation method and device which ensures maximum powder utilization and can be easily adapted for the use of any starting substance.

[0014] The invention is aimed at both manual machines and automatic machines.

[0015] The invention as characterized in the claims, is primarily based on the fact of creating a back pressure of desired value which slows down the flow of the hot water, giving it time to expand throughout the entire mass of powder.

[0016] According to the invention, said back pressure is preferably associated with an expansion chamber positioned between the liquid exit nozzle and the coffee delivery spout, the liquid entering this chamber with a certain speed to mix with the air and produce a creamy emulsion giving an enhanced appearance to the drink.

[0017] The document DE 30 35 157 discloses a device for preparing a creamy espresso coffee in which a back pressure device set downstream the filter increases the pressure inside the filter while the hot water passes through the coffee powder contained therein, to slow down the hot water flow.

[0018] The back pressure device is associated with an expansion chamber, namely an emulsifying chamber, into which the liquid, before reaching the coffee delivery spout, mixes with air and produces a creamy emulsion.

[0019] The creamy emulsion is produced in the emulsifying chamber only at the beginning of the process and absorbs soon all the air present in the emulsifying chamber, therefore afterr few moments from the beginning of the process no further emulsion may be produced.

[0020] The emulsion occupies the whole volume of the emulsifying chamber, up to the coffee delivery spout, and prevents entry of fresh air from the delivery spout.

[0021] The method of the invention is implemented by devices easily associated with manual or automatic machines.

[0022] Said devices enable the object of the invention to be attained by virtue of the characteristics stated in the claims.

[0023] The constructional and functional characteristics of the invention will be apparent from the ensuing detailed description illustrating its various methods of implementation, given by way of non-limiting example with the aid of the figures of the accompanying drawings.

Figure 1 is a partly sectional side view of a percolation chamber suitable for manual machines, in its most simple embodiment.

Figure 2 shows an improved embodiment of the percolation chamber of Figure 1.

Figure 3 shows an embodiment of the invention which can be easily associated with an automatic machine.

Figure 4 is an enlarged detail of Figure 3.

Figure 5 shows a possible variant of Figure 4.

[0024] Figure 1 shows the top piece 1 of a normal espresso coffee preparation machine, to which the percolation chamber is fixed by the known bayonet connector 2.

[0025] This chamber comprises a cup piece 4 provided with a handle 5 and defining a chamber 3 provided with a removable perforated wall 7.

[0026] The wall 7 bounds an underlying chamber 8 for collecting the percolated product, from which it emerges through the nozzle 9.

[0027] Below the nozzle 9 there is provided an emulsifying chamber 10 which is closed by a plug 11 axially bored at 12, and communicates with the spout 13 through which the drink is delivered to the cup.

[0028] The emulsifying chamber 10 comprises a threaded seat 14 coaxial with the nozzle 9, and into which a threaded member 15 provided with operating means 16 is screwed.

[0029] The member 15 is axially hollow to receive an axial pin 17 possibly by way of elastic means 18. The pin 17 is provided at its end with a nosepiece for dosing the nozzle 9, which nosepiece can be an elastomeric ball 19 or a steel needle 190 (as in Figure 5).

[0030] The nosepiece 19, 190 can be rested against the nozzle 9 and be kept pressed by the elastic means 18, or can be positioned at the desired distance from said nozzle by screwing the member 15 into its seat to a greater or lesser extent.

[0031] Figure 2 comprises all the means shown in Figure 1, indicated by the same reference numerals.

[0032] The improved embodiment of Figure 2 also comprises an expansion chamber 20 communicating with the duct of the nozzle 9 via a branch 21.

[0033] The chamber 20, of circular cross-section, comprises a sealed piston 22 maintained at that end close to the nozzle 9 by a spring 23 opposed by the plug 24. The plug 24 is bored at 25 and communicates with the outside.

[0034] Figures 3, 4 and 5 show executive details of the aforedescribed embodiments, suitable particularly but not exclusively for implementing the invention in automatic machines.

[0035] Those details of Figures 3 to 5 corresponding to the details of Figures 1 and 2 are indicated by the same reference numerals.

[0036] The reference numeral 100 indicates a portion of the body of the automatic espresso coffee preparation machine to which the invention is applied.

[0037] In the illustrated example said portion 100 comprises the hot water delivery duct 101, in front of which the piece 102 is fixed such that the axis of the nozzle 9 is aligned with 101.

[0038] This nozzle is provided within a bush 90 having an axial bore and a circular groove 91 positioned in front of the expansion chamber 20 and communicating with the axial bore of the nozzle 9 via a branch 21.

[0039] Below the nozzle 9 there is an emulsifying chamber 10 which is closed by a plug 11 bored axially at 12, and communicates with the drink delivery spout 13.

[0040] The emulsifying chamber 10 comprises a threaded seat 14 coaxial with the nozzle 9, and into which a threaded member 15 provided with operating means 16 is screwed.

[0041] The member 15 is axially hollow to receive an axial pin 17 possibly by way of elastic means 18. The pin 17 is provided at its end with a nosepiece in the form of an elastomeric ball 19 for dosing the nozzle 9.

[0042] The ball 19 can be rested against the nozzle 9 and be kept pressed by the elastic means 18, or can be positioned at the desired distance from said nozzle by screwing the member 15 into its seat to a greater or lesser extent.

[0043] The same applies if a needle 190 is provided instead of the ball.

[0044] In the variant of Figure 5, the throttling means for the nozzle 9 are in the form of a needle 190.

[0045] The invention operates in the following manner. The known procedure is used for coffee percolation.

[0046] According to the invention, by using the operating member 16 to adjust the thrust of the throttling element 19, 190 against the nozzle 9 or its distance from the nozzle 9, a back pressure is created in the percolation chamber 3 which increases the contact time between the hot water and the coffee powder, to ensure optimum utilization of this latter.

[0047] A drink is hence obtained of quality comparatively much better than that obtained with the known system, meaning that for equal coffee powder quality a better drink is obtained, or that for equal powder quality less powder can be used.

[0048] The final drink appearance is rich in cream in that in passing through the gap between the nosepiece 19 and the nozzle at great speed, the drink mixes with the air contained in the chamber 10, to emulsify and assume the enhanced creamy appearance which besides facilitating development of the aroma, gives quality to the drink.

[0049] Perfect execution of the process depends to a substantial extent on the diameter of the nozzle 9, which must be as small as possible compatible with the requirements of throughput and the risk of clogging.

[0050] The embodiment shown in Figures 2 and 4 considerably reduces the risk of clogging.

[0051] In this respect, during percolation, that portion of percolated liquid which initially descends and is the least rich in solid particles fills the chamber 20 by overcoming the elastic resistance of the piston 22, which moves towards the left to compress the spring 23.

[0052] When hot water feed is halted at the end of the process, the liquid contained in the chamber 22 is expelled through the nozzle 9 to clean it of any solid parts, while at the same time it acts below the perforated wall 7 to free any perforations clogged with coffee powder.

Claims

1. A method for preparing espresso coffee or similar drinks in manual or automatic machines, by causing

a forced flow of boiling water to pass through a percolation chamber (3) containing coffee powder, threadably adjustable back pressure being created in the percolation chamber by throttling liquid within an emulsifying chamber (10) to facilitate creation of a creamy emulsion, and collecting the brewed drink through at least one delivery spout (13) of the emulsifying chamber, said emulsifying chamber being in communication with the outside through a bore (12) separated from the delivery spout (13) of the drink.

2. A device for preparing espresso coffee or similar drinks, comprising pressurised hot water generating means, a percolation chamber (3) traversed by hot water and intended to contain coffee powder, and a drink exit conduit, in the form of a nozzle (9) the outlet of which is throttled by threadably adjustable means (19, 190), the nozzle opening into an emulsifying chamber (10) having at least one delivery spout (13) of the drink, said emulsifying chamber communicating with the outside through a bore (12) separated from the delivery spout of the drink.

3. A device as claimed in claim 2, **characterised in that** said emulsifying chamber (10) comprises, coaxial with the nozzle (9), a threaded seat (14) into which a member (15) provided with externally located operating means (16) and carrying said throttling means (19,190) is screwed.

4. A device as claimed in claim 3, **characterised in that** said throttling means are a rubber nosepiece (19).

5. A device as claimed in claim 3, **characterised in that** said throttling means are a needle-shaped pin (190).

6. A device as claimed in Claim 2, **characterised by** comprising an expansion chamber communicating with the nozzle (9), said expansion chamber being a cylindrical chamber (20) open outwards at one end and containing a sealed piston (22) opposed by a spring (23).

7. A device as claimed in claim 2, **characterised in that** the nozzle (9) is formed within an axially bored bush (90) comprising an outer circumferential groove (91) communicating with the axial bore of the nozzle (9)via a radial duct ((21), and with the expansion chamber (20).

Patentansprüche

1. Verfahren zur Zubereitung von Espressokaffee oder ähnlichen Getränken in manuellen oder automatischen Maschinen, indem ein erzwungener Strom von kochendem Wasser zum Durchströmen einer Kaffeepulver enthaltenden Filtrationskammer (3) veranlasst wird, wobei ein per Gewinde regulierbarer Gegendruck in der Filtrationskammer durch Drosselung von Flüssigkeit innerhalb einer Emulgierkammer (10) erzeugt wird, um die.Erzeugung einer cremigen Emulsion zu erleichtern, und durch Sammeln des zubereiteten Getränkes über mindestens eine Ausgabemündung (13) der Emulgierkammer, wobei die Emulgierkammer über eine von der Ausgabemündung (13) für das Getränk getrennte Bohrung (12) mit der Außenseite in Verbindung steht.

2. Vorrichtung zur Zubereitung von Espressokaffee oder ähnlichen Getränken, welche Einrichtungen zur Erzeugung von druckbeaufschlagtem, heißem Wasser, eine von heißem Wasser durchströmte Filtrationskammer (3), die dafür vorgesehen ist, Kaffeepulver zu enthalten, und einen Getränkeaustrittskanal in Form einer Düse (9) aufweist, deren Auslass durch per Gewinde regulierbare Einrichtungen (19,190) gedrosselt ist, wobei die sich in eine Emulgierkammer (10) öffnende Düse mindestens eine Ausgabemündung (13) für das Getränk aufweist, wobei die Emulgierkammer über eine von der Ausgabemündung für das Getränk getrennte Bohrung (12) mit der Außenseite in Verbindung steht.

3. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** die Emulgierkammer (10) koaxial zu der Düse (9) einen mit Innengewinde versehenen Sitz (14) aufweist, in welchen ein mit außen angeordneten Betätigungseinrichtungen (16) versehenes, die Drosselungseinrichtungen (90,190) tragendes Bauteil (15) eingeschraubt ist.

4. Vorrichtung nach Anspruch 3, **dadurch gekennzeichnet, dass** es sich bei den Drosselungseinrichtungen um ein Gummi-Nasenstück (19) handelt.

5. Vorrichtung nach Anspruch 3, **dadurch gekennzeichnet, dass** es sich bei den Drosselungseinrichtungen um einen nadelförmigen Stift (190) handelt.

6. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** sie eine mit der Düse (9) in Verbindung stehende Ausdehnungskammer aufweist, wobei es sich bei der Ausdehnungskammer um eine an einem Ende nach außen offene zylindrische Kammer (20) handelt, die einen abgedichteten Kolben (22) aufweist, dem eine Feder (23) entgegenwirkt.

7. Vorrichtung nach Anspruch 2,
dadurch gekennzeichnet, dass
die Düse (9) innerhalb einer axial gebohrten Hülse (90) ausgebildet ist, die eine äußere Umfangsnut (91) aufweist und mit der Axialbohrung der Düse (9) über einen Radialkanal (21), und mit der Ausdehnungskammer (20) in Verbindung steht.

Revendications

1. Procédé de préparation de café expresso ou de boissons analogues dans des machines manuelles ou automatiques, par circulation forcée d'eau bouillante dans une chambre de percolation (3) contenant de la poudre de café, une contre-pression réglable par vissage étant créée dans la chambre de percolation par étranglement du liquide dans une chambre d'émulsification (10) afin que la création d'une émulsion crémeuse soit facilitée, et la collecte de la boisson infusée par au moins un bec de distribution (13) de la chambre d'émulsification, la chambre d'émulsification communiquant avec l'extérieur par un trou (12) séparé du bec de distribution (13) de la boisson.

2. Dispositif de préparation de café expresso et de boissons analogues, comprenant un dispositif générateur d'eau chaude sous pression, une chambre de percolation (3) parcourue par l'eau chaude et destinée à contenir du café en poudre, et un conduit de sortie de boisson, sous forme d'une buse (9) dont la sortie est étranglée par un dispositif réglable par vissage (19, 190), l'ouverture de la buse dans la chambre d'émulsification (10) ayant au moins un bec de distribution (13) de la boisson, la chambre d'émulsification communiquant avec l'extérieur par un trou (12) séparé du bec de distribution de la boisson.

3. Dispositif selon la revendication 2, **caractérisé en ce que** la chambre d'émulsification (10) comporte un siège taraudé (14) coaxial à la buse (9) et dans lequel est vissé un organe (15) ayant un dispositif (16) de manoeuvre placé à l'extérieur et portant le dispositif d'étranglement (19, 190).

4. Dispositif selon la revendication 3, **caractérisé en ce que** le dispositif d'étranglement est une pièce de nez de caoutchouc (19).

5. Dispositif selon la revendication 3, **caractérisé en ce que** le dispositif d'étranglement est une broche en forme d'aiguille (190).

6. Dispositif selon la revendication 2, **caractérisé en ce qu'**il comprend une chambre de détente communiquant avec la buse (9), la chambre de détente étant une chambre cylindrique (20) qui débouche vers l'extérieur à une première extrémité et qui contient un piston d'étanchéité (22) rencontrant l'opposition d'un ressort (23).

7. Dispositif selon la revendication 2, **caractérisé en ce que** la buse (9) est formée dans un manchon (90) ayant un trou axial et comprenant une gorge circonférentielle externe (91) qui communique avec le trou axial de la buse (9) par un conduit radial (21) et avec la chambre de détente (20).

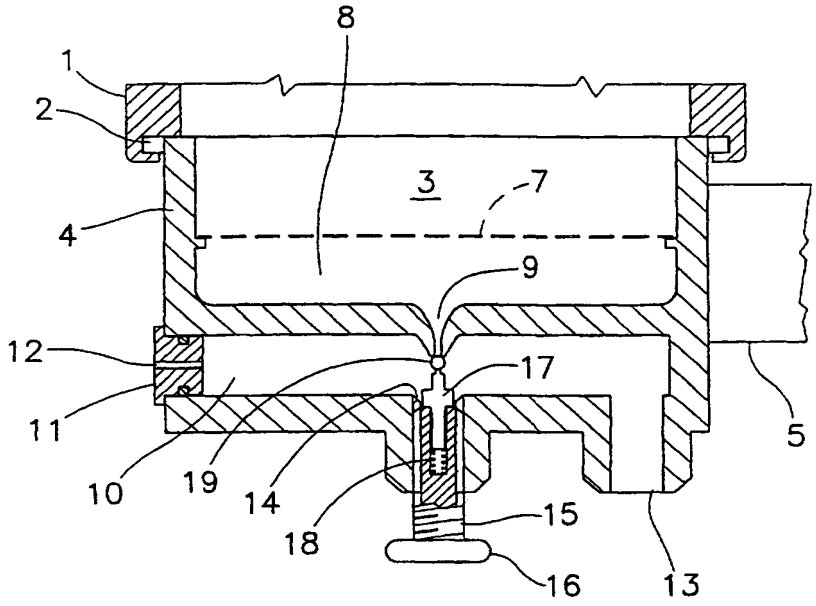
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FIG.1

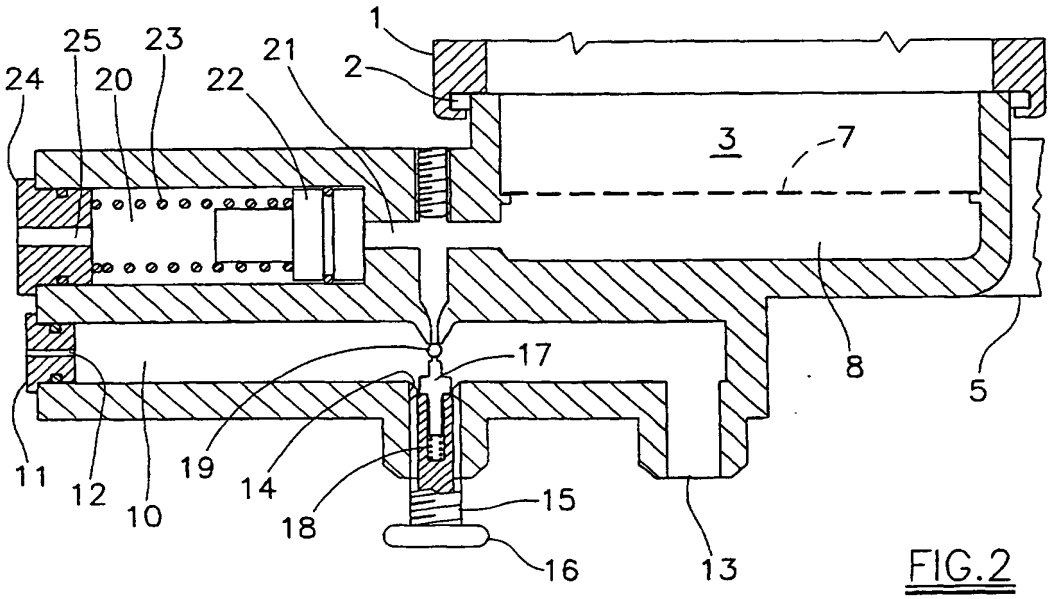
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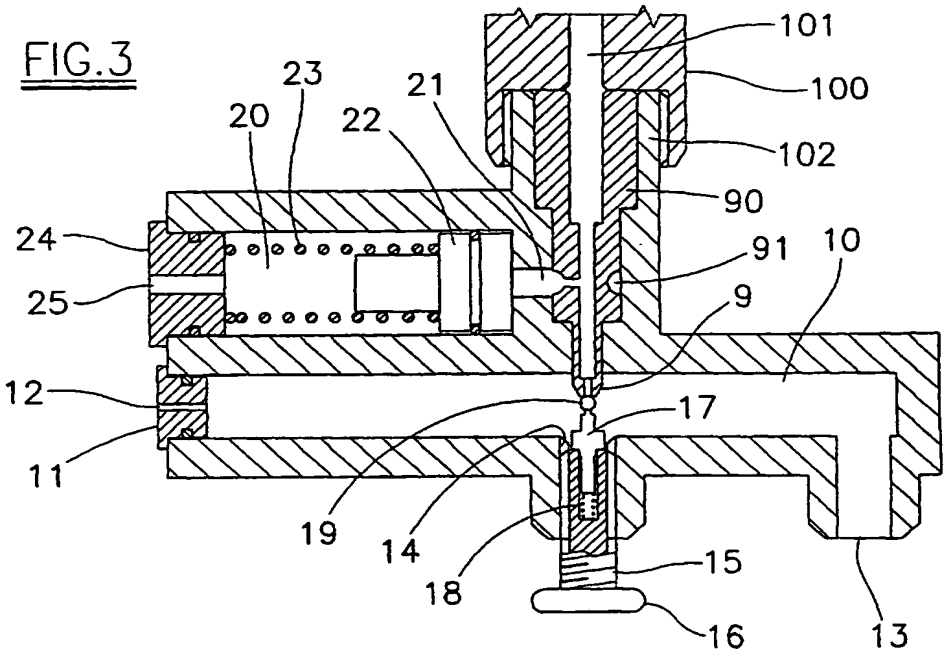
FIG.2

FIG.3



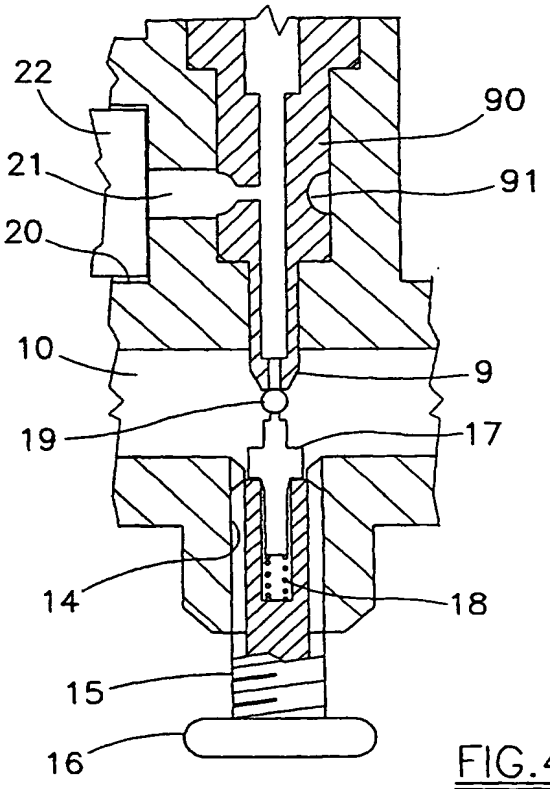


FIG.4

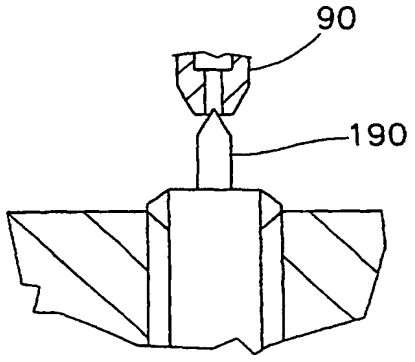


FIG.5

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(54) Title: RE-SYNCHRONIZATION METHOD FOR A COMMUNICATION DEVICE

(57) Abstract: A cellular communication system has a number of cells covered by radio base stations communicating with communication devices. The communication devices have a master timer for internally timing the communication devices relative to a timing of the cellular communication system. The master timer of a communication device is initially synchronized to a timing reference of a radio base station that provides the currently best communication link. Upon initial synchronization, the communication device determines and stores a first channel profile of received multi-path signals relative to the initial synchronization, and then enters a sleep mode. In the sleep mode a timing reference that controls the master timer is switched off. From the sleep mode, the communication device enters a receive mode and switches on its timing reference. The communication device then determines a second channel profile of received multi-path signals, and derives a timing offset signal from a best fit obtained by fitting the first channel profile to the second channel profile. Finally, the communication device re-synchronizes the master timer on the basis of the derived timing offset signal. The first and second channel profiles are characteristic in time to a particular configuration of radio base stations.

Re-synchronization method for a communication device

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a method of re-synchronizing a communication device comprised in a cellular communication system, more particularly to such re-synchronization when the communication device wakes up from a sleep mode after initial synchronization to a radio base station comprised in the cellular communication system.

DESCRIPTION OF THE RELATED ART

Cellular mobile radio or communication systems are well-known. Such cellular mobile radio systems comprise cells or radio zones, together covering a given geographical area. The cells include radio base stations that, through control and communication channels, establish and maintain communication links with mobile radio devices that are comprised in the mobile radio system, and communicate with the mobile radio devices through established communication links.

One type of a cellular communication system is a Universal Mobile Telecommunication System (UMTS) spread spectrum system proposed by the 3rd Generation Partnership Project (3GPP). In the 3GPP ETSI publication ETSI TS 125.213, V3.2.0 (2000-03), pp. 1-27 spreading and modulation is described for a 3GPP UMTS spread spectrum system. In such a system, but also in other systems, radio base stations communicate with mobile radio device using slots based transmission schemes. When the mobile radio device is powered on, it needs to synchronize its internal timing to the timing of the cellular communication system, more particularly to the timing of a radio base station among radio base stations in the neighborhood of the mobile radio station that provides the best communication link. In order for a mobile radio station to be able to synchronize to and establish communication with a particular radio base station, in the proposed 3GPP system the radio base stations repetitively transmit synchronization burst on a so-called primary synchronization channel (PSCH) and a secondary synchronization channel (SSCH) in the form of so-called Golay sequences, and so-called Gold code scrambled signals on a primary

common control channel (PCCCH), as described in the above 3GPP ETSI publication. All radio base stations transmit the same synchronization pattern at their PSCH, transmit different but not uniquely base station identifying synchronization patterns at their SSCH, and eventually base station identifying information at their PCCCH. In a spread spectrum system of a direct sequence type, such as in the proposed 3GPP system, the mobile radio device typically has a so-called Rake receiver with a number of Rake fingers to resolve multi-path received signals and to combine multi-path resolved signals so as to improve the signal-to-noise ratio of the received signal. The timing of the fingers in the Rake receiver is controlled by timing signals generated by a so-called spread spectrum searcher. The searcher is used for initial synchronization of the mobile radio device, upon powering up of the device. After initial synchronization, tracking mode synchronization is adopted. In between multiple slots, in the so-called idle mode, in order to save power, a mobile radio device enters a sleep mode by switching off a major part of its reception circuitry, including its local timing reference, usually a voltage controlled crystal oscillator, while keeping a master timer such as a counter running, but at a substantially lower clock frequency. In the sleep mode, the mobile radio device looses some of its synchronization. Therefore, before reception of a next paging signal from the radio base station, the internal timing of the mobile radio device needs to be adjusted. More particularly, the master timer needs to be re-synchronized to the timing of the radio base station it was previously locked to and, possibly, was communicating with. In systems like the proposed 3GPP system, the re-synchronization process is the same as the initial synchronization process to synchronize to a particular neighboring radio base station, and is a three-step process that is performed by the searcher. Such three-step process is a time and power consuming process. Firstly, after the mobile radio device transitioned from idle mode into receive mode by switching on its timing reference and other circuitry that was switched off during idle mode, the spread spectrum searcher, e.g. implemented as a matched filter, searches for the primary synchronization channel. Within a time slot between successive transmission bursts from the radio base station, at a PSCH synchronization step, the matched filter resolves base station signals of neighboring base stations, without identifying a particular base station. Secondly, at a SSCH synchronization step, in which a matched filtering operation is followed by a fast Hadamard transformation, a non-uniquely base station identifying group code of each resolved base station is obtained. Finally, at a third, PCCCH information reception step, usually performed by a correlator correlating the received PCCCH information with different Gold scrambling codes, the best correlation

match provides the desired radio base station. This three-step process is performed by the searcher both during initial synchronization and re-synchronization.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a fast re-synchronization method, with a minimum number of steps and with minimum power consumption.

It is another object of the invention to provide, upon initial synchronization to a radio base station of the system, re-synchronization to the same radio base station when the communication device wakes up from a sleep mode entered after the initial synchronization.

It is still another object of the invention to provide re-synchronization through fitting of multi-path transmission patterns that are characteristic in time for a particular configuration of radio base stations.

In accordance with the invention, a method of re-synchronizing a communication device that is comprised in a cellular communication system is provided, said method comprising:

initially synchronizing a master timer of said communication device to a first timing reference of a radio base station comprised in said cellular communication system;

determining and storing a first channel profile of received multi-path signals relative to said initial synchronization;

entering a sleep mode after said initial synchronization, in said sleep mode switching off a second timing reference that controls said master timer;

from said sleep mode, entering a receive mode, in said receive mode, switching on said second timing reference;

determining a second channel profile of received multi-path signals;

deriving a timing offset signal from a best fit obtained by fitting said first channel profile to said second channel profile; and

re-synchronizing said master timer on the basis of said derived timing offset signal.

The invention is based on the insight that multi-path transmission patterns that are characteristic in time for a particular configuration of radio base stations do not change over a relatively short period of time such as a period between transmission of multiple time slots, and thus can be used to derive a timing offset for re-synchronization of the communication device after it wakes up from a sleep mode.

Advantageously, the channel profiles are fitted using a mean-square error fitting method, more particularly a mean-square error method fitting replica of said second channel profile to said first channel profile, said replica being time shifted versions of said second channel profile as time shifted over a fraction of a reception time slot of said cellular communication system. Herewith, the timing offset signal is obtained by a simple and robust method.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 schematically shows a cellular communication system according to the invention.

Figure 2 shows a prior art synchronization channel configuration.

Figure 3 shows a communication device according to the invention.

Figure 4 is a timing diagram illustrating adjustment of a master timer in a communication device according to the invention.

Figure 5 illustrates generating of a timing offset according to the invention.

Figure 6 shows adjustment of a counter in a communication device according to the invention.

Throughout the figures the same reference numerals are used for the same features.

DESCRIPTION OF THE DETAILED EMBODIMENTS

Figure 1 schematically shows a cellular communication system 1 according to the invention. The system 1 comprises radio zones 1 to 12, each respectively comprising radio base stations 13-23. A communication device 24 is comprised in the radio zone 7. The device 24 may be a cell phone or handset, or any other suitable communication device. In the example given, the system is a direct sequence spread spectrum system with a slot based transmission scheme. Groups of radio base stations are coupled to switching centers (not shown), and the switching centers are coupled to each other. Such a cellular communication system, which may be a 3GPP system for instance, is well known in the art.

Figure 2 shows a prior art synchronization channel configuration that is used by the system 1. The shown configuration is described in said 3GPP ETSI Publication. Shown is a primary common control channel PCCCH that is used by the radio base stations 13-23 to broadcast data to communication devices in the system 1, and further a primary synchronization channel PSCH and a secondary synchronization channel SSCH. The radio

base stations 12-23 repetitively broadcast data at the common control channel and synchronization patterns at the synchronization channels, using slot based transmission scheme , i.e., transmission is repeated after a time slot 30. For initial synchronization of the communication device 24 to the cellular system 1, when the device 24 is powered up, the communication device is set into a receive mode, and a timing reference is switched on, the device 24 performs a three-step synchronization process. Firstly, a spread spectrum searcher in the communication device 24 searches for a synchronization pattern at the primary synchronization channel PSCH, as broadcast by neighboring radio base stations, then searches for a base station group code at the secondary synchronization SSCH, as received from radio base stations acquired in the first synchronization step, and finally receives data from the acquired radio base stations that uniquely identify the radio base station. The communication device 24 synchronizes to the radio base station that provides the currently best communication link. In between receiving bursts of data from the radio base station, the communication device 24 adopts a sleep mode in which the timing reference, and other reception circuitry not needed in the sleep mode, is switched off. Typically, a multiple slot sleep time is 720 msec. The timing reference is a voltage controlled crystal oscillator, for instance. Before receiving a next data burst from the radio base station, the timing reference and the other switched off circuitry is switched on. Due to switching off of the timing reference, and because it is less accurate and runs at a lower clock frequency when in the sleep mode, the communication device 24 looses some of its synchronization to the system 1. As will be described with reference to Figs. 3-6, re-synchronization of the communication device 24 after the communication device 24 transitioned from the sleep mode to the receive mode uses a far better and faster process than the described initial three-step synchronization process.

Figure 3 shows the communication device 24 according to the invention. In the example given, the communication device 24 is a direct sequence spread spectrum device operating in idle mode, among other modes. In between receiving/transmitting bursts of data, the communication device adopts a sleep mode during which a timing reference is switched off so that some loss of synchronization to the system 1 occurs. The communication device 24 comprises a radio transmission and reception front end 40 that is coupled to an antenna 41. A transmission branch is indicated by Tx. For the purpose of the invention only a reception branch is shown in further detail. The radio front end 40 is coupled to down-mixing means so as to obtain a base band signal, or, possibly, a low intermediate frequency signal from a received radio frequency signal. The down-mixing means can be a single or

multistage quadrature mixer. Shown is a single stage mixer 42. In principle, all signals to be further processed are complex spread spectrum signals. Mixed-down base band or low intermediate frequency spread spectrum signals are sampled by analog-to-digital converters. For reasons of simplicity, only a single analog-to-digital converter 43 is shown. In the example given, the sampled mixed-down complex signal is a base band signal. Programmed processing means and, possibly, further hardware means, processes the sampled mixed-down signals. Such programmed processing means generally comprise a processor, and volatile and non-volatile memory means. To process the sampled mixed-down spread spectrum signals, the communication device 24 comprises a spread spectrum searcher 44, a so-called Rake receiver 45, and a symbol detector 46 that is coupled to an output of the Rake receiver 45. The searcher 44 resolves multi-path received signals, and provides timing information 47 to so-called Rake fingers (not shown in detail) of the Rake receiver 45. The Rake receiver 45 diversity combines resolved multi-path received signals to form a multi-path received diversity combined signal S that is supplied to the symbol detector 46. Such a searcher/Rake receiver is well known in the art. The communication device 24 further comprises a master timer, in the example given a counter 48 that provides a local master timer or clock signal to which operations performed by the communication device are synchronized. Upon initial synchronization, as described, the master timer is synchronized to the system 1. In accordance with the invention, upon waking up from the sleep mode to a receive mode, the master timer is re-synchronized to the system 1 in a fast and simple way.

Figure 4 is a timing diagram illustrating adjustment of the master timer or counter 48 in a communication device according to the invention. In Figure 4A, at a repetition rate of the reception slot 30, multi-path resolved signals BS1, BS2, and BS3 are received from an instant $t=t_0$, from neighboring base stations 19, 18, and 22. A currently best signal, the signal BS1, is received from the radio base station 19, at the instant $t=t_0$. Upon initial synchronization, using the described three-step synchronization process, the counter 48 is synchronized to the radio base station 19. Before entering the sleep mode, according to the invention, the communication device 24 stores a channel profile of received multi-path signals or envelope 50. Figure 4B shows multi-path received signals from the base stations 18, 19, and 22, upon waking up of the communication device 24 from the sleep mode, after some loss of synchronization to the system 1 has occurred, a relative time shift or timing offset $t=t_{offset}$. According to the invention, the relative time shift t_{offset} is determined by fitting the stored envelope 50 to a channel profile or envelope 51 determined upon waking up from the sleep mode, and by adjusting the counter 48 accordingly.

Figure 5 illustrates generating of the timing offset t_{offset} according to the invention. To this end, the searcher 44 comprises a matched-filter 60 that provides peaks and relative timing of the peaks of the received multi-path signals, i.e., of the signals BS1, BS2, and BS3. All received multi-path signal information corresponding to a slot, as provided by the matched-filter, is stored in a buffer 61, and, using a known envelope extraction method, such as a method based upon splines, the envelope 50 is extracted. The extracted envelope 50, with its corresponding timing information, is stored in a memory 63. Upon waking up from the sleep mode, the matched filter 60 provides peaks and relative timing of the peaks of the then received relative time shifted multi-path signals from the base stations 18, 19, and 22. The then extracted envelope 51 is stored in a memory 64. Using mean-square error fitting techniques, that are known as such, the stored envelopes 50 and 51 are fitted, by comparing, in block 65, shifted versions of the envelope 51 to the envelope 50, as shifted over one slot in a number of steps. The timing offset t_{offset} is obtained from the best fit. Instead of using such a mean-square error fitting techniques, other fitting techniques might be used as well. The counter 48 is adjusted by the best fit timing offset t_{offset}.

Figure 6 in more detail shows adjustment of the counter 48 in the communication device 24 according to the invention. Upon initial synchronization, the counter 48 represents the instant $t=t_0$, and after wake up from the sleep mode, the counter 48 represents the instant $t=t_1$. In the receive mode, the counter 48 is clocked by a timing reference or reference oscillator 70, and in the sleep mode, the counter 48 is clocked by a sleep clock 71. The clock frequency of the sleep clock 71 is much lower than the clock frequency of the timing reference 70. Typically, the timing reference runs at 19.68 MHz, and the sleep clock at 32 kHz. The timing reference 70 is switched off when the communications device 24 enters the sleep mode, and is switched on again if the communication device 24 wakes up thereafter. The best fit timing offset t_{offset} as computed as described before, is a reset value that is loaded into the counter 48 upon wake up from the sleep mode, when the counter 48 needs to be adjusted. The reset value is stored in a register 72. Upon resetting, the counter 48, that overflows at the slot rate or a multiple thereof, continues from the loaded reset value. The reset value corresponds to maximally the length of the slot 30. Herewith, a very simple re-synchronization is achieved.

In view of the foregoing it will be evident to a person skilled in the art that various modifications may be made within the spirit and the scope of the invention as hereinafter defined by the appended claims and that the invention is thus not limited to the

examples provided. The word "comprising" does not exclude the presence of other elements or steps than those listed in a claim.

CLAIMS:

1. A method of re-synchronizing a communication device (24) comprised in a cellular communication system (1), said method comprising:

initially synchronizing a master timer (48) of said communication device (24) to a first timing reference of a radio base station (19) comprised in said cellular communication system (1);

determining and storing a first channel profile of received multi-path signals (50) relative to said initial synchronization;

entering a sleep mode after said initial synchronization, in said sleep mode switching off a second timing reference (70) that controls said master timer (48);

from said sleep mode, entering a receive mode, in said receive mode, switching on said second timing reference (70);

determining a second channel profile of received multi-path signals (51);

deriving a timing offset signal (t_{offset}) from a best fit obtained by fitting said first channel profile (50) to said second channel profile (51); and

re-synchronizing said master timer (48) on the basis of said derived timing offset signal (t_{offset}).

2. A method as claimed in Claim 1, wherein said fitting is a mean-square error fitting method.

3. A method as claimed in Claim 2, wherein said mean-square error fitting method fits replica of said second channel profile (51) to said first channel profile (50), said replica being time shifted versions of said second channel profile as time shifted over a fraction of a reception time slot (30) of said cellular communication system (1).

4. A method as claimed in Claim 1, wherein said initial synchronization is performed by synchronizing said communication device (24) to a primary synchronization channel (PSCH) of said cellular communication system (1), by then synchronizing said communication device to a secondary synchronization channel (SSCH) of said

communication system (1), and finally by setting said master timer (48) to said first timing reference of a radio base station (19) providing a best communication link, said synchronization to said primary synchronization channel (PSCH) providing multi-path received signals from neighboring base stations (18, 19, 22), said synchronization to said secondary synchronization channel (SSCH) providing groups codes non-uniquely identifying resolved base stations (18, 19, 22), and said radio base station (19) providing said best communication being identified by a base station identifying code broadcast by said radio base station over a common control channel (PCCCH).

5. A method as claimed in Claim 1, wherein said first and second channel profiles (50, 51) are determined using a signal envelope extracting method based upon splines.

6. A method as claimed in Claim 1, wherein said cellular communication system (1) is a spread spectrum system using a slot based reception mode, and said communication device (24) adopts said sleep mode between multiple time slots of said slot based reception mode.

7. A cellular communication system (1) comprising:

a plurality of cells (2-12) having radio base stations (13-23) covering said cells (2-12);

at least one communication device (24) for communicating with one of said radio base stations (13-23), said communication device (24) having

a master timer (48) controlling internal timing of said communication device (24) relative to a first timing reference of said one of said radio base stations (13-23),

means for initially synchronizing said master timer (48) to said first timing reference,

means for determining and storing a first channel profile of received multi-path signals (50) relative to said initial synchronization,

means for entering a sleep mode after said initial synchronization, in said sleep mode a second timing reference (70) that controls said master timer (48) being switched off,

means for entering a receive mode from said sleep mode, in said receive mode, said second timing reference being switched on (70),

means for determining, in said receive mode, a second channel profile of received multi-path signals (51),

means for deriving a timing offset signal (t_{offset}) from a best fit obtained by fitting said first channel profile (50) to said second channel profile (51), and

means for re-synchronizing said master timer (48) on the basis of said derived timing offset signal (t_{offset}).

8. A cellular communication system (1) as claimed in Claim 7, wherein said communication device (24) comprises mean-square error fitting means to perform said fitting.

9. A cellular communication system (1) as claimed in Claim 8, wherein said mean-square error fitting means is arranged to fit replica of said second channel profile (51) to said first channel profile (50), said replica being time shifted versions of said second channel profile (51) as time shifted over a fraction of a reception time slot (30) of said cellular communication system (1).

10. A communication device (24) for use in a cellular communication system (1) having a plurality of cells (2-12) with radio base stations (13-23) covering said cells (2-12), said communication device (24) being configured to communicate with one of said radio base stations (13-23), said communication device (24) comprising:

a master timer (48) controlling internal timing of said communication device (24) relative to a first timing reference of said one of said radio base stations (13-23),

means for initially synchronizing said master timer (48) to said first timing reference,

means for determining and storing a first channel profile of received multi-path signals (50) relative to said initial synchronization,

means for entering a sleep mode after said initial synchronization, in said sleep mode a second timing reference (70) that controls said master timer (48) being switched off,

means for entering a receive mode from said sleep mode, in said receive mode, said second timing reference (70) being switched on,

means for determining, in said receive mode, a second channel profile of received multi-path signals (51),

means for deriving a timing offset signal (t_{offset}) from a best fit obtained by fitting said first channel profile (50) to said second channel profile (51), and

means for re-synchronizing said master timer (48) on the basis of said derived timing offset signal (t_{offset}).

11. A communication device (24) as claimed in Claim 10, said communication device (24) comprising mean-square error fitting means to perform said fitting.

12. A communication device (24) as claimed in Claim 11, wherein said mean-square error fitting means is arranged to fit replica of said second channel profile (51) to said first channel profile (50), said replica being time shifted versions of said second channel profile (51) as time shifted over a fraction of a reception time slot (30) of said cellular communication system (1).

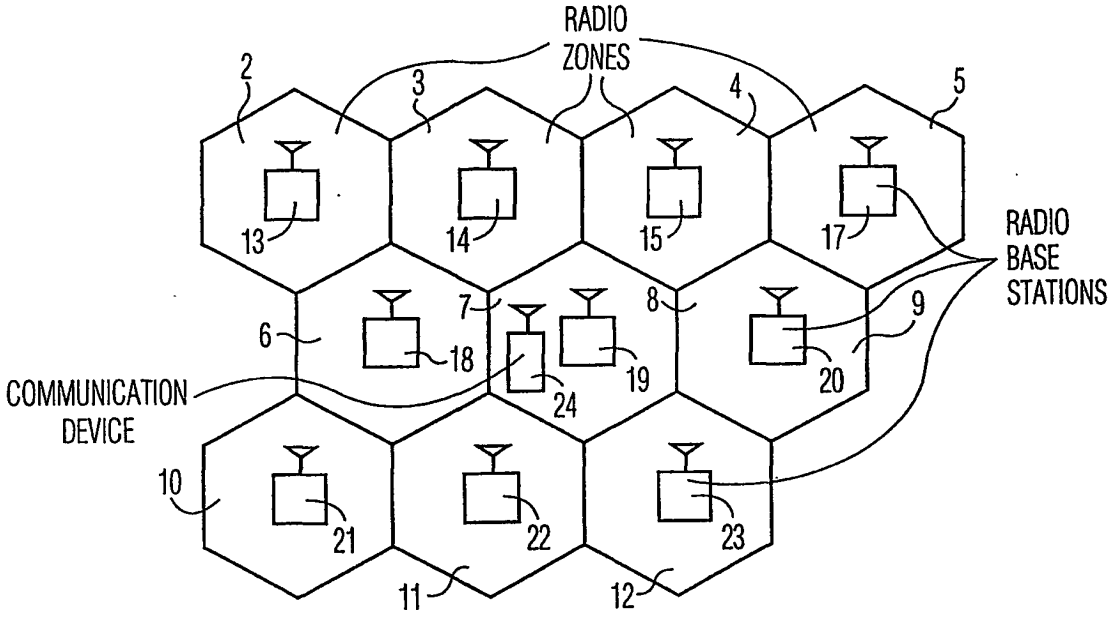
RADIO
ZONES
2
3
4
5
13
14
15
17
RADIO
BASE
STATIONS
6
7
8
9
18
19
20
COMMUNICATION
DEVICE
24
10
21
22
23
11
12

FIG. 1

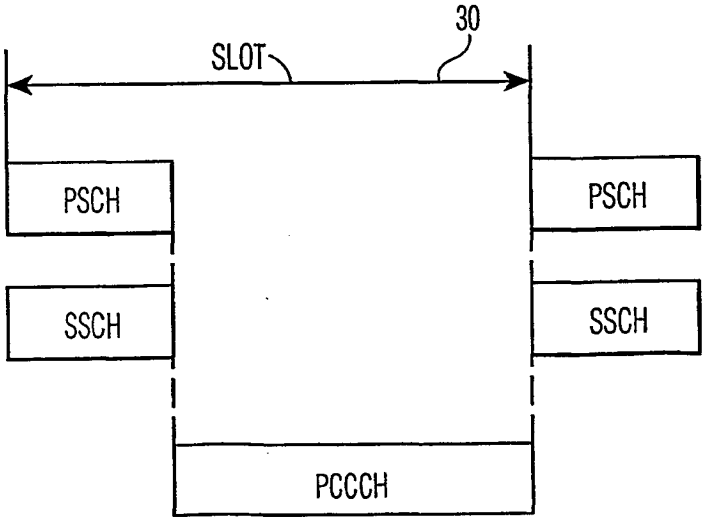
30
SLOT
PSCH
PSCH
SSCH
SSCH
PCCCH

FIG. 2

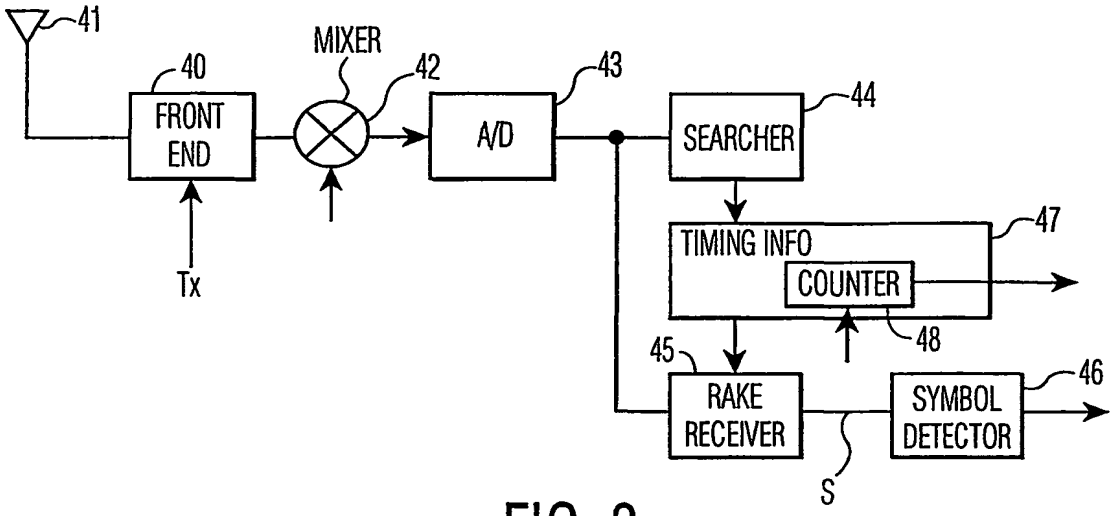

FIG. 3

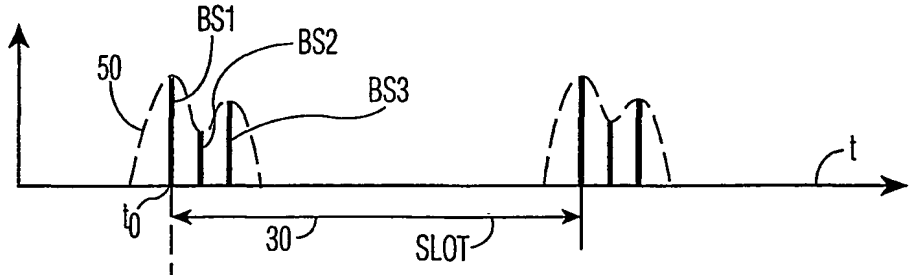

FIG. 4A

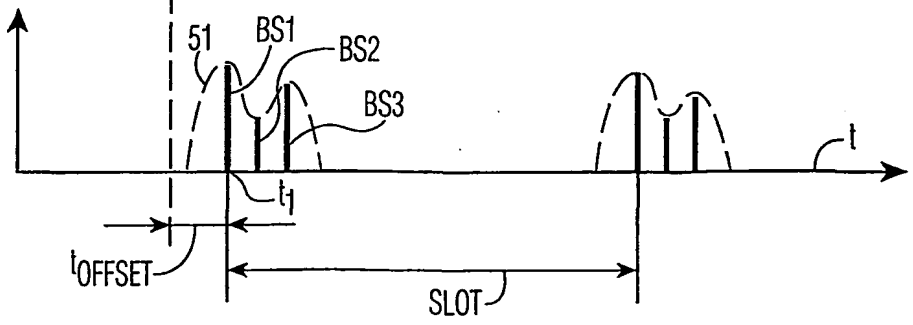

FIG. 4B

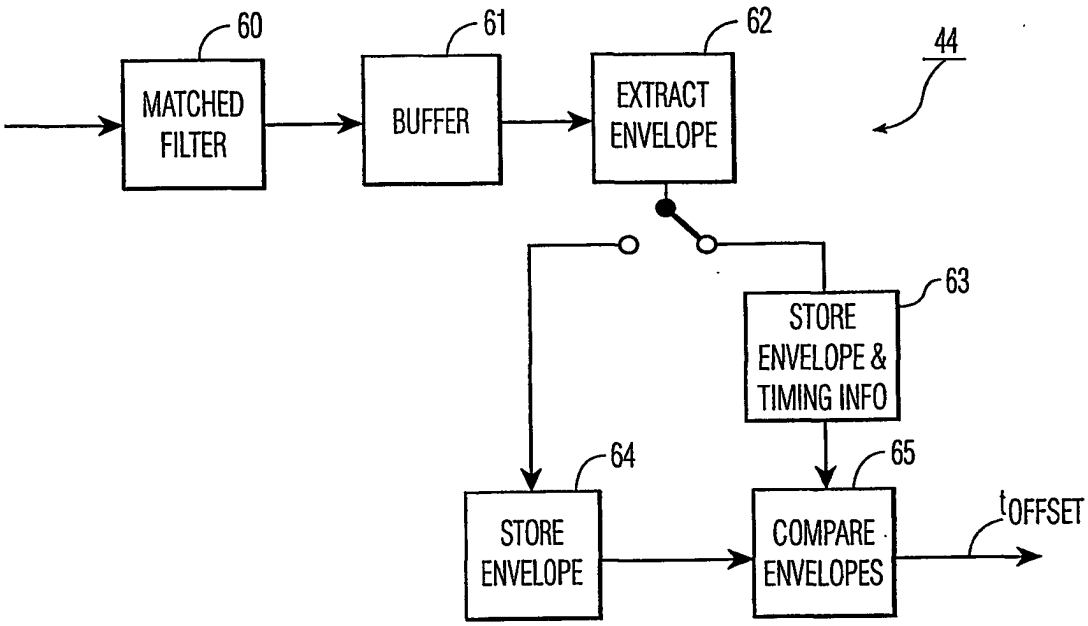
60
MATCHED FILTER
61
BUFFER
62
EXTRACT ENVELOPE
44
63
STORE ENVELOPE & TIMING INFO
64
STORE ENVELOPE
65
COMPARE ENVELOPES
tOFFSET

FIG. 5

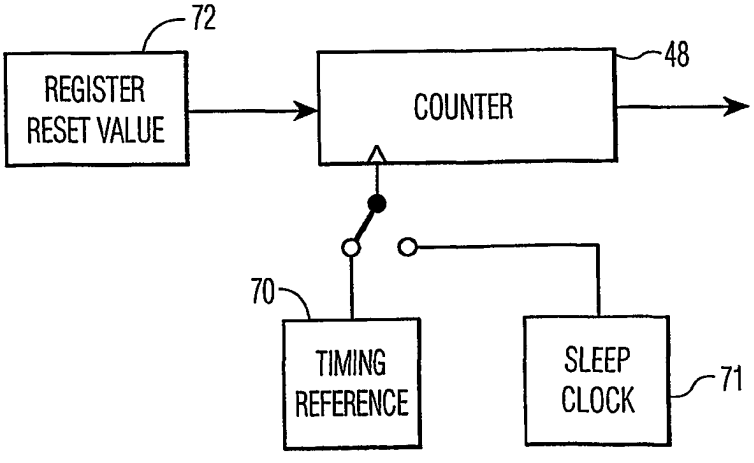
72
REGISTER RESET VALUE
48
COUNTER
70
TIMING REFERENCE
SLEEP CLOCK
71

FIG. 6